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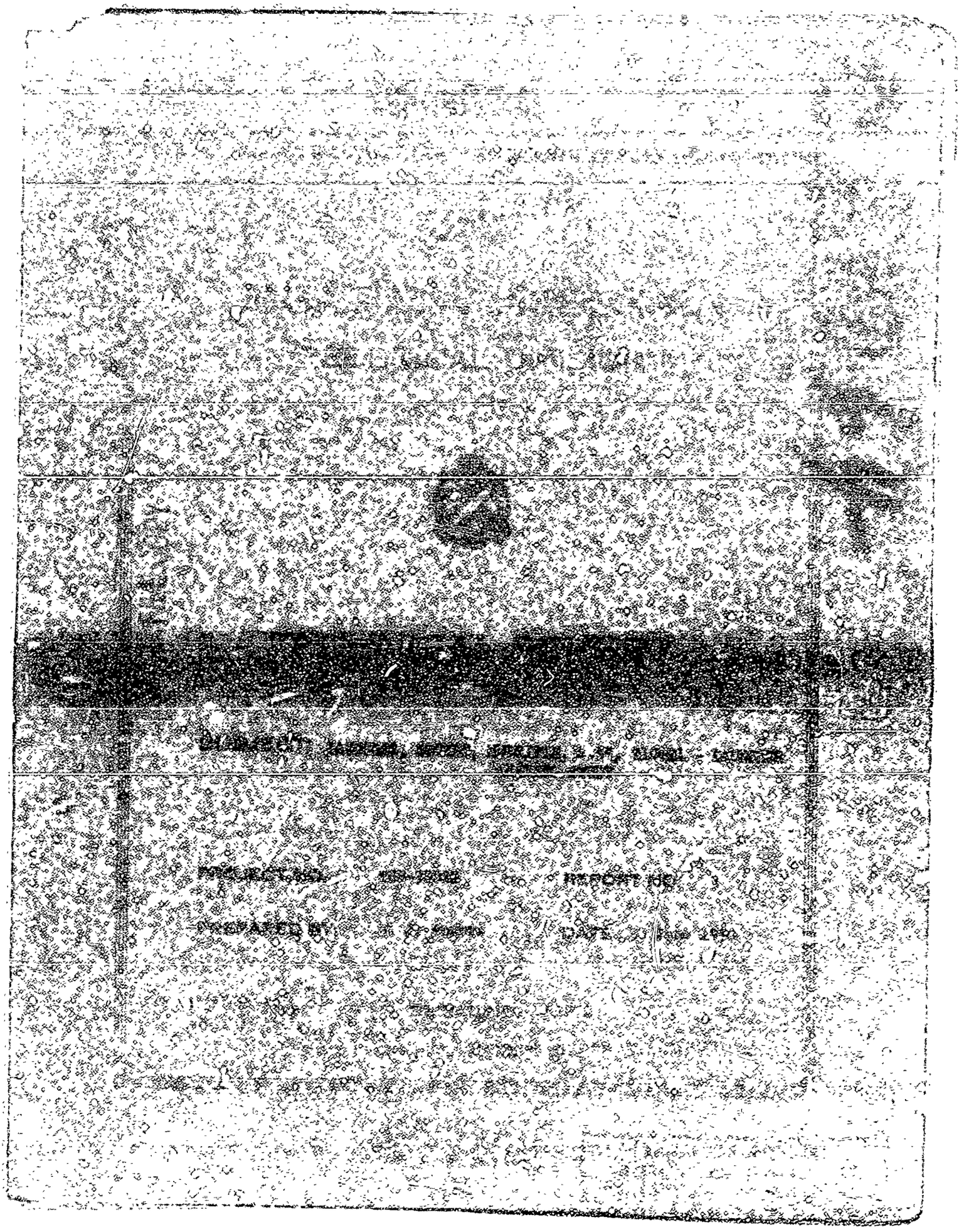

AD 398392

(6) LAUNCHER, ROCKET, MULTIPLE, 4.5 IN., T106E1 - LAUNCHER HEATING STUDY [U]. (8)

(16) ORD-

Project No. TU2-3002D

Final Report No. 3

Picatinny Arsenal Technical Report No. 1772

(11) 30 Jun 50

Prepared by:

(10) W. J. Powers
Materials Engineer

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PICATINNY ARSENAL

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Project No.: TU2-3002D Final Report No. 3

DOA Priority: 2A

Project Title: Launcher, Rocket, Multiple, 4.5", T106E1 - Launcher Heating Study

OBJECT

To develop an all-plastic rocket launching tube which will reduce or eliminate over-heating and will withstand firing 100 rounds. In connection with the over-all launcher, to investigate related non-metallic parts, including the blast mat and the front plate.

SUMMARY

Various all-plastic rocket launcher tubes which had previously undergone partial firing tests were subjected to outdoor weathering for 8 months and were further tested under actual firing conditions. It was found that this exposure did not adversely affect the bursting or delamination resistance of the tubes but that a tube equipped with firing rails became useless after five rounds following the exposure period. It was not known whether the failure was induced by the outdoor exposure or whether the fatigue limit of the metal rivets holding the firing rails had been nearly reached in previous firing tests. The initial and interim development of plastic launcher tubes capable of withstanding the firing of 100 rounds was reported in Picatinny Arsenal Technical Reports Nos. 1704 and 1763.

A reinforced plastic protective front end ring was developed which withstood twenty rounds and which on examination appeared that it would be satisfactory for many more rounds. Two woven steel blast mat specimens, one impregnated with rubber withstood 10 firings and with modifications this construction might be developed into a satisfactory blast mat.

CONCLUSIONS

All-plastic launcher tubes which do not become seriously hot and which withstand firing for 100 rounds and are unaffected by outdoor exposure have been developed. These tubes consist of a thin inner liner of asbestos fabric or asbestos paper with a melamine-formaldehyde resin, covered with a high strength glass fabric impregnated with a melamine-formaldehyde or polyester resin. The asbestos liner provides the best erosion and delamination resistance, while the outer layer provides the high bursting strength required.

The finished tubes are integral units.

Further development work would be required to develop a plastic tube equipped with rails in order that under prolonged firing or severe weathering conditions functioning of the tube would not be impaired by failure of the rivets holding the firing rails in place. This problem is not within the plastics field.

A reinforced plastic front end ring has been developed which in preliminary testing appears to have the necessary bursting and erosion resistance. A paper base laminate appears acceptable as a front plate material provided it is backed with steel to provide sufficient mechanical strength.

Preliminary testing indicates that a suitable blast mat might be prepared using a steel mesh cloth covered with rubber. The steel will supply the high strength required and the rubber will act as a dustproof material and as an insulating material. Further development work will be required to develop a blast mat suitable for field use.

RECOMMENDATIONS

It is recommended that the development work covered in this report be used as a basis for procuring plastic rocket launcher tubes, and as a basis for the design of launchers incorporating plastic tubes. It is recommended that a study be made of methods and materials used for attaching firing rails to the launcher tube in order that loosening of the firing rails and subsequent difficulty in loading will be prevented.

It is also recommended that further work toward developing a blast mat be continued along the lines discussed in Paragraph 13 of this Report.

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INTRODUCTION:

1. A major cause of dissatisfaction with multiple rocket launchers as designed and used in World War II was the tendency of the steel tubes to overheat. This was undesirable because (a) as the propelling charge was heated, the ballistics of the rocket changed, (b) if rockets were allowed to remain in hot launching tubes there might be leakage of molten TNT as the heat was transferred to the rocket, and (c) the reloading of the launcher was less rapid when personnel had to avoid touching hot areas. Accordingly, work was initiated on this project in an effort to provide tubes that did not become hot upon repeated firings.

2. Since the multiple rocket launchers must be mobile and of relatively simple construction for field use it was not considered feasible to make use of standard forced air or water cooling techniques. Possible methods considered for preventing the overheating of multiple rocket launchers tubes were; (1) the use of plastic tubes with a very low thermal conductivity, (2) the attachment of fins to metal tubes to provide additional surface area for cooling, (3) to increase the heat capacity of the launchers by using materials of high specific heat and by adding as much weight as possible, and (4) by using thermally insulated steel tubes. This report covers only the development of plastic tubes and related plastic components as a means of preventing the overheating of rocket launcher assemblies.

3. Preliminary investigations had shown (Ref A) that plastic tubes were superior to metal tubes because the plastic tubes did not become hot under the influence of repeated but intermittent blasts of rocket gases. Bursting and delamination of the tubes were found to be the most serious problems with plastic tubes. An interim solution of these problems was reported in Picatinny Arsenal Technical Report No. 1704 whereby an aluminum sleeve was placed over a high pressure molded asbestos laminate liner. The aluminum sleeve gave the assembly sufficient bursting strength, while the plastic liner furnished delamination resistance and low heat transfer.

4. The development and initial testing of an all plastic launcher tube (a tube without a metal sleeve) which reduces heating and withstands firing 100 rounds of 4.5" M17E1 rockets, inert loaded, without bursting or delamination was reported in Picatinny Arsenal Technical Report No. 1763. Covered also in this Report were the testing of different constructions of all plastic tubes both with and without firing rails, initial development work on a plastic protective front end ring for the launcher tube, and the testing of a ceramic and a plastic laminate for possible use as thermal insulating materials on the metal front plate.

5. It is well known that when multiple rocket launchers are emplaced and fired over dry unsodded terrain that the backward blasts from the emerging rockets impinge on the ground and create considerable dust. This dust is in the form of a cloud which lingers near the launcher for a con-

siderable period (especially on a windless day) and provides the enemy with an excellent marking of the launcher location. A suggested solution for overcoming this problem was the spreading of a suitable mat over the area where the gases impinge. Accordingly, the Office of the Chief of Ordnance was interested in the possibility of developing a suitable mat (O.O. 471.94/2113, ORDTU-RIA 474.9/369, ORDBB 471.84/2156) and directed (O.O. 471.94/2695, ORDBB 471.94/2015-18) that the development of a blast mat be conducted concurrently with the plastic launcher tube.

6. Preliminary testing had shown (O.O. 471.94/2113, RIA 474.9/369 Incl 2 1, ORDBB 471.94/2156) that a fire resistant canvas mat fastened to the ground by steel stakes driven through grommets was completely destroyed after firing three rounds and that a mat fabricated from glass and silicone type rubber was also destroyed after firing one round. Failure of a vinyl coated non-rigid nylon fabric blast mat test section after one round was reported in Picatinny Arsenal Technical Report No. 1763.

RESULTS:

7. A group of four plastic launcher tubes which had previously been partially tested in actual rocket firings was exposed to the weather for eight months and then further tested in actual rocket firings. The results are as follows:

Tube No.	Inner Liner	Outer Shell	Number of Rockets Previously Fired	Number of Rockets Fired After Exposure	Remarks [1]
2	molded asbestos paper melamine resin	molded glass fabric melamine resin	71	27	No bursting or delamination, tube in good condition. Erosion after 71 rounds, at front of tube .007", at rear of tube .138". Total erosion after 98 rounds, at front of tube .013", at rear of tube .193". All the erosion resistant asbestos liner was worn away at the extreme rear of this tube.
3	molded asbestos paper melamine resin	molded undirectional glass fabric melamine resin	27	27	No bursting or delamination, tube in good condition. Erosion at front of tube after first 27 rounds .003-.006", at rear of tube .025-.026". Total erosion after second 27 rounds, at front of tube .005-.006", at rear of tube .057".

Tube No.	Inner Liner	Outer Shell	Number of Rockets Previously Fired	Number of Rockets Fired After Exposure	Remarks[1]
8	molded asbestos fiber melamine resin	glass fabric polyester resin	26	24	No bursting or delamination, tube in good condition. Erosion after 26 rounds, at front of tube .002", at rear of tube .015-.027". Total erosion after 50 rounds, at front .003-.004", at rear of tube .046".
10	molded asbestos fabric melamine resin	glass fabric melamine resin	72	7	This tube equipped with firing rails. After 57 rounds a small portion, 1/4" x 3/4", at the rear of the liner was blown out. Otherwise, prior to the exposure the tube was in good condition. On the fifth round after the exposure there was slight difficulty in sliding the rocket in place. On the seventh round the rocket had to be forced in place. Further testing was discontinued. Examination of the tube showed that several of the rivets holding the firing rails in place had failed permitting the rails to spring slightly from the tube. The plastic part of the tube appeared to be still in good condition. It was observed after after exposure that the protective steel front ring had rusted. This was not serious enough to interfere with its functioning.

[1] All measurements of erosion were taken on the diameter.

8. A reinforced plastic front end ring was machined to give a force fit on tube No. 3 and was evaluated simultaneously with the tube for twenty seven rounds. Examination of the ring indicated that it would probably withstand a great many more rounds. Photographs of the ring before and after the firing tests are in M36845.

9. Two woven steel cloths, one impregnated with neoprene rubber, were tested for possible use in blast mats by placing in back of the launcher. The steel cloth was torn and the individual wires in the cloth were fused after one round. The cloth impregnated with rubber withstood 10 rounds and showed evidence of erosion and hardening of the rubber. However, it would probably have functioned for more rounds. Photographs of the cloths are in M36844 and M36748.

DISCUSSION OF RESULTS:

10. It was originally intended that this phase of the work cover the development of tubes equipped with rails, most acceptable considering firing life, weight requirements, cost and availability of materials, construction details, and methods of manufacture. Further work on the development of protective front end rings and blast mats was to be carried on concurrently with the launcher tube development. However, it was considered that sufficient knowledge and technique to develop a satisfactory plastic launcher tube had been acquired and that there was no need to pursue the work any further at this time. Accordingly, in compliance with a letter dated 24 Jan 1950 from Redstone Arsenal to this Arsenal (RST 470/489, ORDBB 3309-475) action was taken to complete the weather exposure tests of the plastic tubes and to bring the project to a close with this final report.

11. The development of all plastic tubes, with and without rails, capable of withstanding repeated rocket firings (up to 100) was discussed in Picatinny Arsenal Technical Report No. 1763. It was found in the current investigation that outdoor exposure for a period of eight months did not adversely effect the bursting or delamination resistance of plastic tubes that previously had withstood firing from 26 to 72 rounds but that a tube (#10) equipped with rails which had previously withstood 72 rounds, became useless after five rounds following the exposure period due to failure of the rivets holding the rails in place. Further firing tests on other tubes equipped with rails would be necessary to ascertain the cause of the rivet failure by showing that it was either hastened or caused by the outdoor exposure or that the fatigue limit of the metal had been nearly reached in firing tests previous to the exposure period.

12. The protective plastic front end rings previously tested had proved greatly deficient in bursting strength at the high rates of loading encountered in rocket firings. Examination of the end rings after firing indicated that heat or flame resistance was of secondary importance compared with high tensile or bursting strength. Accordingly to meet these requirements front end rings were constructed having a flame resistant and erosion

resistant exterior of asbestos laminate with a glass fabric resin interior to supply the high strength required to prevent bursting. This construction is very similar to that required and used in the main portion of the launcher tube. The ring tested withstood 27 rounds without breaking and it appeared that it would last many more.

13. The materials previously tested for use as blast mat materials had proved greatly deficient in the necessary properties such as high tensile, high tear strength, and resistance to delamination. These materials were glass, cotton, or nylon fabrics impregnated with a plastic or a rubber. Since in the development of the launcher tube, protective end rings, and front plate material, it had been shown, that despite the intense flame, heat resistance was of secondary importance compared to high strength and delamination resistance in the materials used. Therefore the logical step would be to use a material having exceeding high strength and with good delamination resistance. To meet these requirements a mat was made of woven steel impregnated with neoprene rubber. The steel mat test specimen with the rubber impregnation withstood ten rounds and probably would have withstood more rounds. The mat as fabricated had some exposed steel wires on the surface. It appears that this is an undesirable feature since the exposed steel is an excellent heat conductor and heats the entire steel-rubber mass quickly on firing a round. This caused failure due to hardening and charring of the rubber more quickly than if only the surface of the exposed rubber had been heated. The steel mat test specimen without the neoprene rubber failed badly after one round due to tearing and partial fusion of the steel wires. It appears that the rubber serves to distribute the stress more evenly to the steel and to act as a thermal insulator for the steel as well as making a dustproof barrier.

EXPERIMENTAL PROCEDURE:

14. All firings were made from a mount attached to the carriage of a 75 mm cannon. Further details regarding firing techniques are reported in Picatinny Arsenal Technical Report No. 1704. The experimental blast mat test specimens were placed approximately 30 inches to the rear of the launcher tube and perpendicular to the long axis of the tube against a steel plate. The tubes were exposed to the weather for 8 months at a 45° angle facing south on a wooden rack 5 ft above the ground.

MATERIALS USED:

15. The rockets used were 4.5" M17E1 Rockets assembled at Picatinny Arsenal. It was desirable to use a spin stabilized rocket since the trend in rockets for ground force is toward such rockets. These were inert loaded and were constructed as shown in Drawing 82-16-16, Rev 5, with a closing plug in place of a fuze and the lead wire hanging out through the nozzle for ease in firing. The propellant was standard double-base rocket propellant.

16. The tubes used are partially described in Appendix A. The blast

mat material is described in Appendix B. Detailed information regarding the tubes and front end rings may be found in Ref B and C .

REFERENCES:

A. Picatinny Arsenal Chemical Laboratory Report No. 119227, 4 Nov 1946, "Non-Metallic Rocket Launching Tubes".

B. Final Report Contract No. W-36-034 ORD 7678 Dept of the Army, National Vulcanized Fibre Co., 24 March 1950.

C. Final Report on Overheating of Multiple-Tube Rocket Launchers, Contract No. W19-020-ORD 6445, Dept of the Army, Arthur D. Little, Inc. 15 Sept 1949.

INCLOSURES:

Appendices A and B
Photographs M36844, M36845, M36748

Report by:

W. J. Powers
Materials Engineer

Reviewed:

L. Gilman
Chief, Plastics Research Section

D. D. Sager
Assistant Chief for Research and Chemistry

Approved:

C. R. Dutton
Col, Ord Dept
Chief, Technical Division

APPENDIX A

Tube No.

2 Inner layer - molded 0.013" asbestos paper with melamine resin, ID of inner layer 4-9/16", OD of inner layer 4-11/16.

Outer layer - molded # 128 "Fiberglas" with melamine resin, ID of outer layer 4-11/16", OD of outer layer 5-1/16".

Source - National Vulcanized Fibre Company

3 Inner layer - molded asbestos fabric with melamine resin, ID of inner layer 4-9/16", OD of inner layer 4-11/16".

Outer layer - molded unidirectional "Fiberglas" # 165 with melamine resin, ID of outer layer 4-11/16", OD of outer layer 5-1/16".

Source - National Vulcanized Fibre Company

8 Inner layer - molded asbestos fabric with melamine resin, ID of inner layer 4-9/16", OD of inner layer 4-11/16".

Outer layer - convolute wound "Fiberglas" with polyester resin, ID of outer layer 4-11/16", OD of outer layer 4-15/16".

Source - Liner furnished by National Vulcanized Fibre Company. Outer layer and final construction made by Universal Molded Products Corp.

10 Inner layer - the liner is asbestos fabric with melamine resin.

Outer layer - the outer layer is glass cloth impregnated with a melamine resin.

Comments - Detailed notes regarding this tube are given in Ref C.

APPENDIX B

The woven steel blast mat test specimens were fabricated from low carbon (0.010%) steel by Metal Textiles Corp, Roselle, N.J. The diameter of the steel wire used was .C10" with a mat thickness of 0.36". The following neoprene rubber composition was used to impregnate one mat:

*GR-M-10	100
magnesium oxide	4
zinc oxide	5
stearic acid	1
coumarone-indene resin	5
phenyl alpha naphthylamine	1
HAF carbon black	35
tributoxy ethyl phosphate	5
light process oil	5

Curing was accomplished in a press for 15 minutes at 155°C.

* A polymer of 2 chlorobutadiene 1,3 supplied by Office of Rubber Reserve, Reconstruction Finance Corp.

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Steel Mesh Blast Test Specimens with and without Rubber Impregation.

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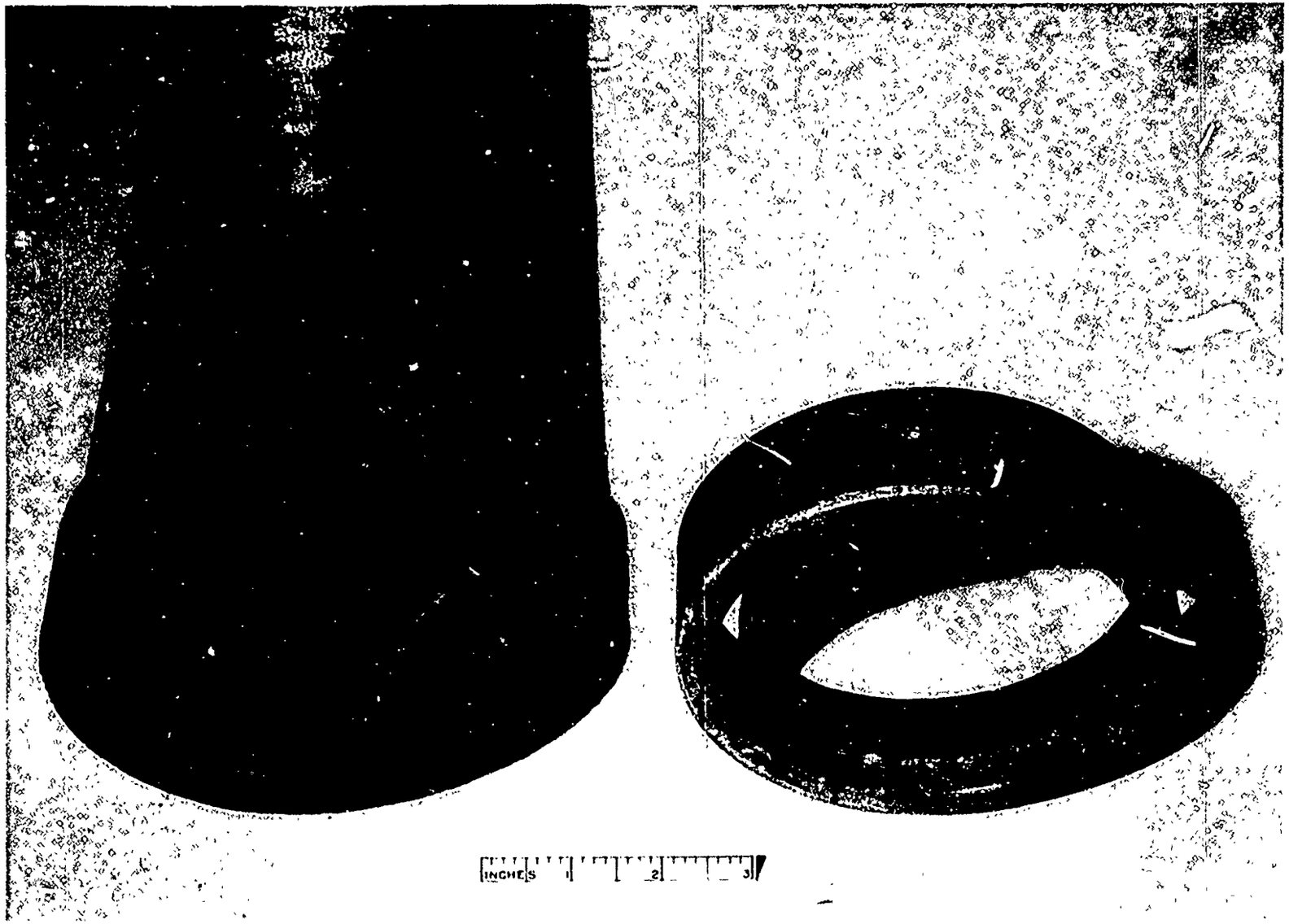

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Reinforced Plastic Protection Front End Ring.

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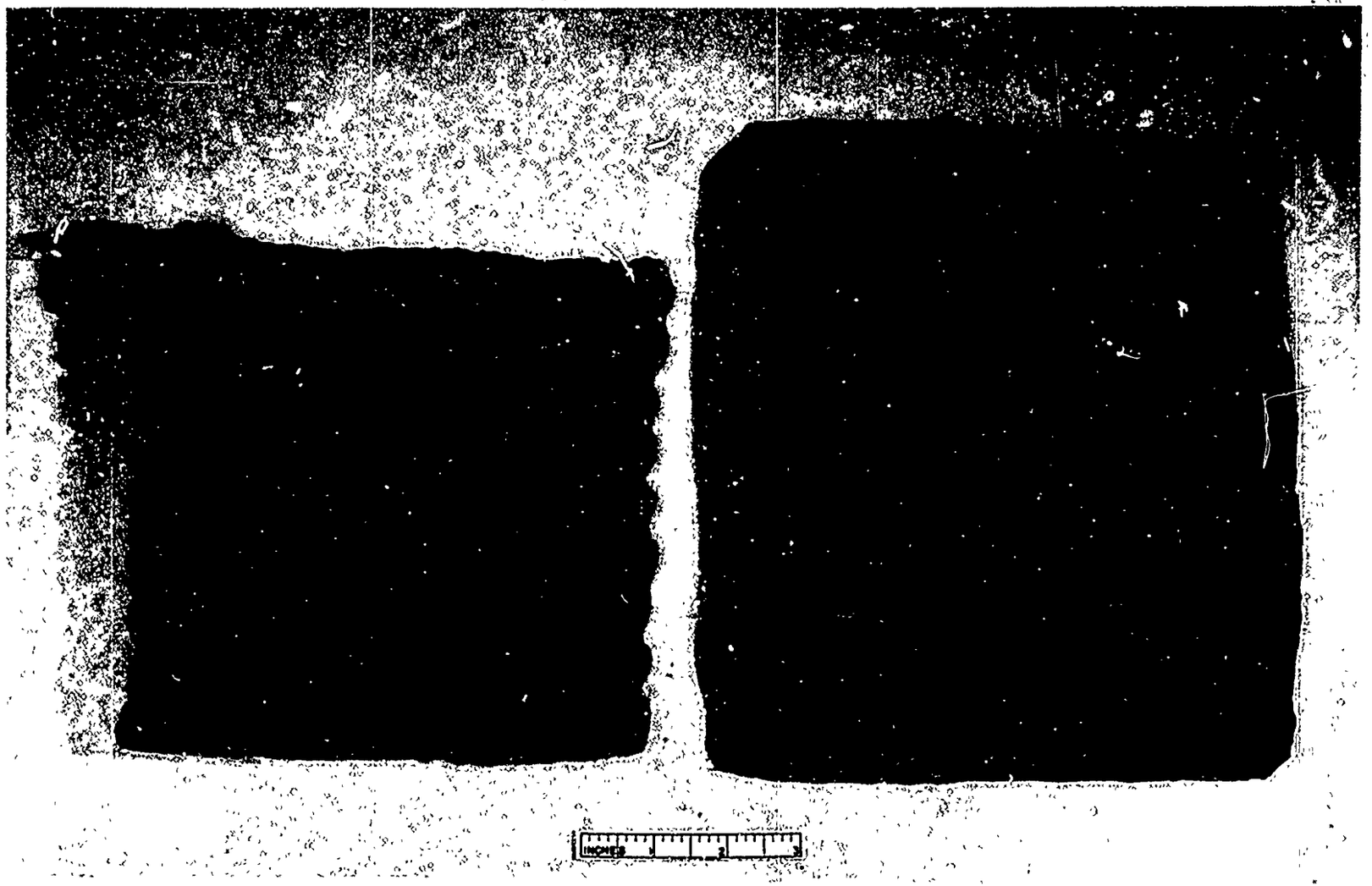

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Experimental Wire Mesh Blast Mats with and without Rubber Impregation.